CLAIMS

We claim:

1. A process for the catalytic conversion of at least one reactant in a thermal chemical reaction, excluding deep oxidation, comprising:

passing at least one reactant into at least one reaction chamber;

said reaction chamber comprising a catalyst that catalyzes the reaction of said at least one reactant;

transferring heat to or from said at least one reaction chamber into at least one heat exchanger; and

obtaining at least one product from said reaction chamber;

wherein said step of transferring heat, at steady state, transfers at least 0.6 W/cc of total reactor volume, where total reactor volume is defined as the sum of the volume of the reaction chamber(s) and heat exchanger chamber(s) including the volume of chamber walls;

wherein the contact time of the reactant with the catalyst is less than about 0.3 seconds; and

wherein the pressure drop through the reaction chamber is less than about 15 psig.

2. A process for the steam reforming of a hydrocarbon comprising:

passing a feed stream comprising hydrocarbon gas and steam into a reaction chamber;

said reaction chamber comprising a catalyst that catalyzes the reaction of said hydrocarbon gas and water gas to produce a gaseous mixture comprising at least carbon monoxide and hydrogen gas;

wherein said process produces more than 0.01 SLPM of hydrogen gas per cubic centimeter of reactor volume, where reactor volume is defined as the sum of

the volume of the reaction chamber(s) and heat exchanger chamber(s) including the volume of chamber walls.

3. A reactor for the catalytic conversion of at least one reactant in a thermal chemical reaction, comprising:

at least one reaction chamber;

wherein said reaction chamber comprises a porous catalyst insert;

at least one heat exchanger in thermal contact with said reaction chamber;

wherein said reaction chamber has a length less than or equal to 6 inches and a height less than or equal to 2 inches; and

wherein said porous catalyst insert comprises a porous metal foam having open cells ranging from about 20 ppi to about 3000 ppi.

4. A process for the catalytic conversion of at least one reactant in a thermal chemical reaction, excluding deep oxidation, comprising:

passing at least one reactant into at least one reaction chamber;

said reaction chamber comprising a porous catalyst that catalyzes the reaction of said at least one reactant;

transferring heat to or from said at least one reaction chamber into at least one heat exchanger; and

obtaining at least one product from said reaction chamber;

wherein said reaction chamber has a height less than or equal to 2 inches; and

wherein said porous catalyst comprises a porous metal having open cells ranging from about 20 ppi to about 3000 ppi.

5. The process of claim 1 wherein said catalytic conversion is selected from the group consisting of: acetylation, addition reactions, alkylation, dealkylation, hydrodealkylation, reductive alkylation, amination, aromatization, arylation, autothermal reforming, carbonylation, decarbonylation, reductive carbonylation, carboxylation,

reductive carboxylation, reductive coupling, condensation, cracking, hydrocracking, cyclization, cyclooligomerization, dehalogenation, dimerization, epoxidation, esterification, exchange, Fischer-Tropsch, halogenation, hydrohalogenation, homologation, hydration, dehydration, hydrogenation, dehydrogenation, hydrocarboxylation, hydroformylation, hydrogenolysis, hydrometallation, hydrosilation, hydrolysis, hydrotreating, hydrodesulferization/hydrodenitrogenation (HDS/HDN), isomerization, methanation, methanol synthesis, methylation, demethylation, metathesis, nitration, oxidation, partial oxidation, polymerization, reduction, steam and carbon dioxide reforming, sulfonation, telomerization, transesterification, trimerization, water gas shift (WGS), and reverse water gas shift (RWGS).

19. A process for the catalytic conversion of at least one reactant in a thermal chemical reaction, excluding deep oxidation, comprising:

passing at least one reactant into at least one reaction chamber;

said reaction chamber comprising a catalyst that catalyzes the reaction of said at least one reactant;

transferring heat to or from said at least one reaction chamber from or into said at least one heat exchanger; and

obtaining at least one product from said reaction chamber;

wherein said step of transferring heat, at steady-state, transfers at least 0.6 W of heat per cc of total reactor volume, such that, at steady state, the catalyst is maintained within a temperature range that reduces the formation of at least one undesirable chemical reaction product.

7. A process for the catalytic conversion of at least one reactant in a thermal chemical reaction, excluding deep oxidation, comprising:

passing at least one reactant into at least one reaction chamber;

said reaction chamber comprising a porous catalyst that catalyzes the reaction of said at least one reactant;

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transferring heat to or from said at least one reaction chamber from or into at least one heat exchanger; and

obtaining at least one product from said reaction chamber;

wherein said porous catalyst comprises a metal support; and

wherein the contact time of the reactant is less than about 0.3 seconds, thereby suppressing slow reactions and the formation of at least one undesirable chemical reaction product.

8. The catalytic process of claim 7 wherein the desirable reaction is the water-gas shift reaction, with desirable products being carbon dioxide and water, and an undesirable product is methane.

9. The catalytic process of claim 7 wherein the desirable reaction is steam reforming of a hydrocarbon, with the desirable products being hydrogen and carbon monoxide and/or carbon dioxide, and where an undesirable product is coke.

10. A reactor for the catalytic conversion of at least one reactant in a thermal chemical reaction, comprising:

at least one reaction chamber;

wherein said reaction chamber comprises a porous catalyst insert;

at least one heat exchanger in thermal contact with said reaction chamber;

wherein said reaction chamber has a height less than or equal to 2 inches; and

wherein said at least one heat exchanger and said at least one reaction chamber are configured such that, during steady-state operation, at least 0.6 W of heat per cc of total reactor volume can be transferred between said at least one heat exchanger and said at least one reaction chamber.

11. A method for suppressing formation of at least one undesirable chemical reaction product in a thermal chemical reaction, comprising:

passing at least one reactant into at least one reaction chamber;

said reaction chamber comprising a porous catalyst that catalyzes the reaction of said at least one reactant;

transferring heat to or from said at least one reaction chamber from or into at least one heat exchanger; and

obtaining at least one product from said reaction chamber;

wherein said porous catalyst comprises a metal support; and

comprising at least one of the following process steps:

at steady-state, transferring at least 0.6 W of heat per cc of total reactor volume, such that, at steady state, the catalyst is maintained within a temperature range that reduces the formation of at least one undesirable chemical reaction product; or

maintaining the contact time of the reactant at less than about 0.3 seconds, thereby suppressing slow reactions and reducing the formation of at least one undesirable chemical reaction products.

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12. The method of claim 11, wherein said thermal chemical reaction is steam reforming and said of at least one undesirable chemical reaction product comprises coke.